

## SYSTEM FOR STORING SPLICES IN A JOINT BOX

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to commonly assigned U.S. Patent Application Serial No. 09/399,752, filed September 21, 1999 and entitled "Fiber Retaining System;" and U.S. Patent Application Serial No. 09/399,751, filed September 21, 1999 and entitled "Fiber Retaining System," both of which are hereby incorporated by reference herein.

### FIELD OF THE INVENTION

The present invention relates to the retention and protection of spliced optical fibers. More specifically, the invention relates to an arcuate retainer for organizing and securing fiber optic splices.

### BACKGROUND OF THE INVENTION

Communications networks are frequently made of many miles of optical fibers. Indeed, many of the networks can extend between continents and across oceans and other large bodies of water. For protection, the optical fibers are contained in a larger cable. An example of such a cable is shown in FIG. 1. The cable 2 includes an outer insulating plastic coating 4, a copper sheath 6 inside the outer coating 4, and high strength members, such as steel wires 8, inside of the copper sheath 6. A loose tube 10 is contained within the steel wires 8, and one or more isolated optical fibers 12 are contained within the loose tube 10. This permits the fibers 12 to move with respect to the steel wires 8, the sheath 6 and the coating 4. This cable arrangement has been found to be desirable in many high strength applications.

As neither the cables nor the fibers can be made and deployed in infinite lengths, sections of the cables and the fibers are attached together. The fibers are typically attached to each other by a process known as splicing. For protection from the environment, these spliced sections are commonly contained in a watertight housing, which is frequently referred to as a joint box. Such housings or joint boxes are also used when it is necessary to make splices in the field.

In circumstances when tension is applied to the cable, such as during the deployment of the cable underwater by a ship, it is undesirable to have the splice absorb the forces. Thus, on either side of the splice, a great deal of slack, such as three feet of fibers, may be provided to prevent the splice from being stressed. The joined fibers, with their slack, may be coiled onto a center section of the joint box, wound around cylinders or stored in magazines adjacent a center section of the joint box. The splice itself is fixed within the center section.

Traditionally, multiple splices are placed in each joint box. However, most arrangements do not make efficient use of the limited space in a joint box and do not adequately restrain splices to prevent damage. Thus, a need exists to organize splices in a manner that does not lend itself to damaging the splices and makes efficient use of limited space in a joint box.

## SUMMARY OF THE INVENTION

In view of the foregoing, it is an aspect of the present invention to provide an arrangement for organizing and protecting spliced optical fibers in a joint box.

It is a further aspect of the present invention to provide an arcuate splice retainer for retaining a plurality splices. The retainer may be in a joint box and may include a first arcuate-shaped storage channel for retaining more than one of the plurality of splices. The retainer may include a first element having a convex surface forming a bottom portion of the first channel, and a second element having a concave surface forming a top portion of the first channel and retaining the more than one splices in the first channel between the first and second elements. The first element may include a center step and end steps in the lateral ends of the first element. The center step and the end steps may extend the length of the first retainer. The retainer may further include a second arcuate-shaped storage channel for storing more than one of the plurality of splices, wherein the second channel is radially spaced from the first channel with respect to a longitudinal axis parallel to longitudinal axes of said plurality of splices. The retainer may also include a third element having a concave surface forming a top portion to the second channel, and the second element having a convex surface forming a bottom portion to the second channel. The splices in the first and second channel may be secured in a static position. The retainer may further include a third arcuate-shaped storage channel angularly spaced from the first channel and radially spaced from the second channel with respect to the longitudinal axis, wherein the third channel is for retaining more than one of the plurality of splices, and the first and third channels are separated by the center step. The second element may be removably attached to said first element, and the third element may be removably attached to the second element.

A further aspect of the present invention may include a joint box with a middle section and a center shelf. The center shelf may longitudinally divide the middle section into first and second compartments, and a first retainer may be positioned on the center shelf in the first compartment. A second retainer may be positioned on the center shelf in the second compartment.

Another aspect of the present invention may include a fiber optical network, and the joint box and splices of the present invention may be a part of the fiber optical network.

The above and other features and advantages of the present invention will be readily apparent and fully understood from the following detailed description of preferred embodiments, taken in connection with the appended drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view of a cable;

FIG. 2 is a schematic top view of the joint box and the arcuate retainer of the present invention;

FIG. 3 is a schematic side sectional view of the joint box and the arcuate retainer of the present invention;

FIG. 4 is a perspective view of the joint box and the arcuate retainer of the present invention;

FIG. 5 is a cross-sectional view of the arcuate retainer; taken through line 5-5 of FIG. 2; and

FIG. 6 is a perspective view of the arcuate retainer shown partially assembled.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Details of the cable and fiber joining system for housing and protecting spliced optical fibers are shown in FIGS. 2-6. FIG. 2 schematically depicts the housing or joint box 20 connecting the free ends of two cables 2 together. The joint box 20 and optical fibers 12 are preferably part of an extensive fiber optical communications network that may extend long distances, *e.g.* below a large body of water. The cables 2 are preferably of the type shown in FIG. 1 such that the optical fibers 12 can move longitudinally with respect to the remainder of the cable 2. The optical fibers 12 of the cables 2 are joined by splicing the fiber ends, using any well-known method, and creating splices 5. The splices 5 are preferably reinforced with protective sleeves 9 (see FIG. 6) at the area of the splice for protecting the fiber connection. Sufficient slack 13 in the fibers 12 is provided to prevent the splices 5 from being stressed or pulled into one of the cables 2. The slack 13 from the fibers 12 may be coiled onto the shelf 52.

The joint box 20 includes cable termination sections 24 at its longitudinal ends, and a center section 22 disposed between, and connecting, the cable termination sections 24. Each cable termination section 24 includes a body 26 with a cone-shaped hollow cavity therein, and a cone-shaped plug and sleeve configuration 28 that fits within the hollow cavity. The high strength steel wires 8 of the cables 2 are clamped between the hollow cavity of the body 26 and the plug and sleeve 28, and the outer surface of the sleeve is malleable, which deforms around the high strength steel wire 8 as the plug is inserted. The body 26 and the plug and sleeve configuration 28 are hollow along their central axis 30. This enables the fibers 12 to extend unrestrained therethrough.

The center section 22 is disposed between and connected to the cable termination sections 24, and houses and protects the spliced section of the fibers 12. The center section 22 is attached to the cable termination sections 24 by a bayonet-type locking arrangement or any known desirable arrangement. The joint box 20 also includes a cover 14 (see FIG. 5) for enclosing its interior.

In a preferred embodiment, the center section 22 includes a shelf 52 that generally divides the center section 22 into upper and lower compartments or sections 32 and 34, as shown in FIG. 3. In such an arrangement, an arcuate retainer 92 can be included on one or both of the upper and lower sides of the shelf 52. FIG. 3 shows an arcuate retainer in upper compartment 32, and an arcuate retainer in lower compartment 34, shown with dashed lines, which may be provided to accommodate more splices. However, it is recognized that a shelf 52 need not be provided and that a single arcuate retainer 92 may be used.

FIGS. 2-6 show the arcuate retainer 92 for storing and securing the splices 5 in a static position. The retainer 92 includes a base 93 having a portion with an upper surface 96 having an arcuate shape. The base 93 is preferably removably attached to shelf 52 with screws 21. However, the base 93 may be formed as part of the shelf 52 or permanently attached to the shelf 52. The upper surface 96 preferably includes a center step 61 and lateral steps or ledges 62 in the base 93 on opposing sides of center step 61. Each of the steps 61 and 62 extend longitudinally, preferably for the length of the arcuate retainer 92. The steps 61 and 62 help define an area for organizing and placing splices 5 on the base when a middle cover 94 is attached to the base 93. Also, the center step 61 divides the area for storing the splices 5. As shown in FIG. 5, the splices 5 are placed on the arcuate outer convex surface 96 of base 93. The center step 61 of the base 93 divides the area for storing splices 5 into two sections 100 and 101 which are arcuate-shaped storage channels. Sections 100 and 101 are curved in a plane perpendicular to the longitudinal axis of the splices 5 stored in the sections. In addition sections 100 and 101 are angularly spaced from a longitudinal axis 7. By providing two storage sections 100 and 101, the splices 5 are organized, so the fibers 12 connected to the splices 5 are less susceptible to being tangled. In addition, organizing the splices 5 in two sections allows the splices 5 to be quickly identified, since the splices 5 are not all grouped together. This can be beneficial when utilizing fibers in multiple bundles. Also, if desired, the upper surface 96 may be grooved (not shown) or otherwise subdivided, so each splice can fit in between two grooves when placed on the base. The grooves can help maintain the splices 5 in a static position when the splices 5 are secured by a cover.

As shown in FIG. 5, the middle cover 94 rests on the center step 61 and the lateral ends 64 of the base 93. The middle cover 94 includes a concave lower surface 98 that provides the top boundary of

storage sections 100 and 101. Like base 93, middle cover 94 includes a center step 71 and lateral steps or ledges 72 on opposing sides of the center step 72 in the lateral ends of the middle cover 94. Each of the steps 71 and 72 extend longitudinally, preferably the length of the retainer 92. The steps help define additional areas 102 and 103 for organizing and placing splices 5. The lateral steps 72 also help support splices 5. In addition, the center step 71 of middle cover 94 divides the area for storing the splices into two sections 102 and 103 which are arcuate-shaped channels. Similar to sections 100 and 101, sections 102 and 103 are angularly spaced from the longitudinal axis 7 of the joint box 22, and sections 102 and 103 are curved in a plane perpendicular to the longitudinal axis of the splices stored in the sections. Also, as shown in FIG. 5, sections 100 and 101 are radially spaced from sections 102 and 103 respectively, and sections 100 and 101 are radially and angularly spaced from sections 103 and 102 respectively.

The middle cover 94 is preferably removably attached to the base 93 with recessed middle cover screws 105. The middle cover screws 105 are positioned on the lateral sides of the lateral steps 72 and on the top of center step 71 in order to affix middle cover 94 to the center step 61 and lateral steps 62 of the base 93. The screws 105 extend through the middle cover 94 into the base 93. When middle cover 94 is screwed into the base 93, the splices 5 in sections 100 and 101 are secured by the middle cover 94 against the base 93. The width of each of the storage sections 100-103 is generally the same as the width of a splice 5, except the width of each of the storage sections 100-103 is slightly less in order to provide a light clamping force. The length of the screw hole for screws 105 are designed so that when the middle cover 94 is screwed into the base 93, enough pressure is applied to the splices 5 in sections 100 and 101 to provide the light clamping force to secure the splices in a static position without damaging the splices 5. Also, the middle cover 94 includes an arcuate convex upper surface 97 for placing splices 5 thereon. If desired, the upper surface 97 may be grooved or subdivided as described for upper surface 96.

A top cover 95 includes a concave lower surface 107 that provides the top portion of the storage sections 102 and 103. The top cover 95 is removably attached to the middle cover 94 with top cover screws 106 that affix the top cover 95 to the center step 71. Other top cover screws 106 affix the top covers 95 to the lateral sides of the lateral steps 72 of middle cover 94. It is recognized that the screws 105 and 106, and their associated holes are positioned to avoid interference with one another. The top cover 95 secures the splices 5 in sections 102 and 103 against the middle cover 94 without damaging the splices 5.

The arcuate shape of the base 93 and covers 94 and 95, which define arcuate storage sections 100-103, make efficient use of the limited space in a joint box for storing the maximum number of splices. Indeed, the joint box 20 is preferably circular in cross section, and the arcuate shapes of the splice storage sections 100-103 are preferably generally radial. Accordingly, this maximizes the storage space inside the

joint box 20. Additionally, the arcuate shape allows the splices to be layered and organized, so the splices are readily identifiable and accessible.

The base 93 as shown is generally circularly shaped, but the base 93 may be oval, square, octagonal or any desirable shape.

Although, the preferred embodiment of arcuate retainer 92 includes two layers of fibers, the arcuate retainer may include more than two covers to accommodate more than two layers of fibers. Furthermore, any desirable arrangement for removably attaching the covers may be implemented. Also, the covers 94 and 95 and the base 93 may be made of high strength steel or other materials with the requisite strength and durability. In addition, if desired, a metal cover, not shown, is attached around the body 3, and a plastic sleeve, also not shown, may sealingly surround the entire joint box 20 in a conventional manner for waterproofing and insulating purposes.

The present invention has been described in terms of preferred and exemplary embodiments thereof. Numerous other embodiments, modifications and variations within the scope and spirit of the appended claims will occur to persons of ordinary skill in the art from a review of this disclosure.